

S P E C I F I C A T I O N

Docket No. 0230G-101

0230G-101

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN that I, Bradford G. Corbett, Jr., a citizen of the United States, residing in Ft. Worth, Texas, have invented new and useful improvements in a

PIPE BELLING APPARATUS AND METHOD

of which the following is a specification:

"EXPRESS MAIL" NO. EL13916440545

I hereby certify that this paper or fee is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated below and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Date of Deposit: 10-2-00

By: Barak Turner

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates generally to sealing systems for thermoplastic pipes and, specifically, to an improved belling apparatus and process for installing a gasket in a socket end of a thermoplastic pipe.

2. Description of the Prior Art:

Pipes formed from thermoplastic materials including polyethylene and PVC are used in a variety of industries. In forming a joint between sections of pipe, the spigot or male pipe end is inserted within the female or socket pipe end. An annular, elastomeric ring or gasket is typically seated within a groove formed in the socket end of the thermoplastic pipe. As the spigot is inserted within the socket, the gasket provides the major seal capacity for the joint. It is critical, during the installation process, that the gasket not be able to twist or flip since a displaced or dislocated gasket will adversely affect the ultimate sealing capacity of the joint.

A variety of other shortcomings have existed in such pipe joints of the prior art. For example, unintentional earth loading, such as traffic load, can be transferred to the socket end of the pipe sections, leading to deformations and associated leakage in the joints. Certain heat strains in the pipes, such as can occur on storage in hot weather or by close proximity to heat

1 sources can result in deformations, shrinkage of the pipe
2 material and resulting leakage.

3

4 One early attempt to ensure the integrity of such
5 pipe joints was to provide local reinforcement of the
6 groove portion of the socket end by means of a heavier
7 wall thickness in this region of the pipe. In some
8 cases, reinforcing sleeves or external connecting
9 mechanisms were also utilized. Each of these solutions
10 was less than ideal, in some cases failing to provide the
11 needed joint integrity and often contributing to the
12 complexity and expense of the manufacturing or field
13 assembly operations.

14

15 In the early 1970's, a new technology was developed
16 by Rieber & Son of Bergen, Norway, referred to in the
17 industry as the "Rieber Joint." The Rieber system
18 employed a combined mould element and sealing ring for
19 sealing a joint between the socket end and spigot end of
20 two cooperating pipes formed from thermoplastic
21 materials. In the Rieber process, the elastomeric gasket
22 was inserted within an internal groove in the socket end
23 of the female pipe as the female or belling end was
24 simultaneously being formed. The provision of a
25 prestressed and anchored elastomeric gasket during the
26 belling process at the pipe factory provided an improved
27 socket end for a pipe joint with a sealing gasket which
28 would not twist or flip or otherwise allow impurities to
29 enter the sealing zones of the joint. These features
30 increased the reliability of the joint and decreased the
31 risk of leaks or possible failure due to abrasion or
32 other factors. The Rieber process is described in the

1 following issued United States patents: 4,120,521;
2 4,061,459; 4,030,872; 3,965,715; 3,929,958; 3,887,992;
3 3,884,612; and 3,776,682.

4

5 Certain of the polyolefin materials were not well
6 adapted for use in the Rieber-type process. Polyethylene,
7 for example, after being heated has a tendency to return
8 to its original shape. Thus, after a bell connection is
9 formed using the traditional Rieber techniques of
10 heating, forming and cooling, the end result is a shape
11 that is not stable.

12

13 Accordingly, an object of the present invention is
14 to provide a method of installing a gasket in a socket
15 end of a thermoplastic pipe, including a polyethylene
16 pipe, in a Rieber-type process which provides a stable
17 shape upon cooling.

18

19 Another object is to provide such a manufacturing
20 technique which is simple to implement and which provides
21 reliable results.

22

23 Another object of the invention is to provide an
24 integral gasket within the socket end of a polyethylene
25 pipe which is securely retained within a receiving groove
26 which is integrally formed about the gasket during the
27 manufacturing step.

28

29 Another object of the invention is to allow the
30 manufacturing of very large diameter gasketed pipe at a
31 lower cost than traditional methods.

SUMMARY OF THE INVENTION

3 A method is shown for installing a gasket in a
4 socket end of a thermoplastic pipe which is used to form
5 a pipe coupling. A mandrel is provided with an inner
6 extent and an outer extent and having a generally
7 cylindrical outer working surface. A gasket is installed
8 at a first circumferential position on the outer working
9 surface. An extruded strip of thermoplastic material is
10 spirally wrapped about the working surface of the mandrel
11 and over the gasket, whereby the thermoplastic material
12 is conformed to the shape of the gasket. A leading
13 portion of the gasket again contacts the working surface
14 of the mandrel to form a bell connection. The bell
15 connection with the integrally contained gasket can then
16 be retracted from the working surface of the mandrel. The
17 thus formed bell connection can be electrowelded onto a
18 generally cylindrical length of thermoplastic pipe to
19 form a pipe joint.

20 In a preferred embodiment of the invention, a
21 rotatably driven mandrel is provided having a
22 substantially cylindrical end section corresponding to
23 the internal diameter of a bell connection to be formed.
24 The mandrel has an outer extent and an inner extent and
25 also has a locating area for an elastomeric gasket on an
26 external working surface thereof. The elastomeric gasket
27 is positioned on the external surface of the mandrel at
28 the locating area thereof, the locating area being
29 between the inner and outer extents of the mandrel. A
30 bell connection is then formed about the mandrel and
31 suitably located gasket by extruding a melt profile made

1 of thermoplastic material onto the mandrel beginning
2 adjacent the inner extent of the mandrel and spirally
3 winding the melt profile around the cylindrical end
4 section of the mandrel and around the gasket such that
5 adjacent windings of the melt profile make contact and
6 are fused. The bell connection thus formed is then cooled
7 and the bell connection and gasket are stripped from the
8 mandrel.

9

10 Additional objects, features and advantages will be
11 apparent in the written description which follows.

DRAFTS-2000

BRIEF DESCRIPTION OF THE DRAWINGS

3 Figure 1 is a simplified, partially schematic view
4 of the apparatus and method of the invention showing the
5 mandrel upon which the thermoplastic material is being
6 extruded and wrapped;

8 Figure 2 is a side, partial cross-sectional view of
9 the mandrel used in the method of the invention showing
10 the elastomeric gasket located on the external working
11 surface thereof;

13 Figure 3 is a view similar to Figure 2, showing the
14 beginning of the extrusion step of the method of the
15 invention;

16
17 Figures 4 and 5 are a continuation of Figure 3
18 showing the further extrusion steps of the method of the
19 invention:

21 Figure 6 is a side, partial cross sectional view
22 showing the bell connection and integral gasket having
23 been stripped from the forming mandrel:

Figures 10-13 are simplified, schematic views of the prior art Rieber process for installing a gasket in a socket end of a thermoplastic pipe.

1 DETAILED DESCRIPTION OF THE INVENTION

2

3 The advantages of the method of the invention can
4 best be understood with reference to a simplified
5 discussion of the prior art Rieber process. Turning
6 first to Figures 7-10, the prior art process is
7 illustrated. Figure 7 shows a section of a conventional
8 elastomeric sealing gasket 11 having a steel reinforcing
9 ring 13 in place on the generally cylindrical outer
10 working surface 15 of the mandrel 17 used in the belling
11 process. The elastomeric gasket 11 can be formed of, for
12 example, rubber and is a ring shaped, circumferential
13 member having an inner compression surface 19 and an
14 exposed nose portion 21 which, as shown in Figure 1,
15 abuts a forming collar 23. The forming collar 23 has a
16 first generally cylindrical extent 25 which is joined to
17 a second cylindrical extent 27 by a step region 29,
18 whereby the second extent 27 is of greater external
19 diameter than the first cylindrical extent 25, shown in
20 Figure 7.

21

22 In the first step of the prior art process, the
23 steel reinforced elastomeric ring 11 is thus placed onto
24 the working surface of the mandrel 17 and pushed to a
25 position against the back-up or forming collar 23. In
26 this position, the gasket is firmly anchored to the
27 mandrel surface with the rubber between the mandrel and
28 the steel-ring of the gasket being compressed by
29 approximately 20%.

30

31 In the second step of the prior art process, the
32 socket end 33 of the thermoplastic pipe 31 is heated and

1 pushed over the steel mandrel 17, gasket 11 and back-up
2 collar 23. The socket end 33 is expanded due to the
3 thermoplastic nature of the pipe. A number of
4 thermoplastic materials, such as Polyvinylchloride (PVC)
5 are known in the prior art having the required expansion *Riebe*
6 characteristics, depending upon the end application of
7 the pipe joint.

8

9 The socket end 33 flows over the first cylindrical
10 extent 25 of the back-up collar 23 and abuts the step
11 region 29 in the second step of the process (see Figure
12 8).

13

14 In the next step of the prior art process (Figure 9)
15 hydraulic cylinders are actuated to move the mandrel and
16 pipe away from the back-up collar 23 and the pipe socket
17 end 33 retracts around the mandrel and gasket 11 due to
18 the elastic forces of the thermoplastic material.
19 Typically, vacuum was also applied through ports 35, 37
20 which connected the mandrel working surface with a vacuum
21 source (not shown).

22

23 In the final step of the prior art process (Figure
24 10), the pipe socket end 33 is cooled by means of a water
25 spray bar 39 and spray nozzles 41. As the cooling takes
26 place, the pipe socket end 33 shrinks around the gasket
27 11, thus compressing the rubber body of the gasket
28 between the steel reinforcing ring 13 and the socket-
29 groove to establish a firm seal.

30

31 The above described Rieber process has been in
32 commercial use since the early 1970's and is described in

1 the above referenced issued United States patents, among
2 other sources. It will thus be well familiar to those
3 skilled in the thermoplastic pipe sealing arts.

4

5 Turning to Figure 1, there is shown the improved
6 apparatus and method for forming a bell connection for a
7 thermoplastic pipe having an integral gasket. The
8 apparatus includes a mandrel 43 which is a generally
9 cylindrical member including an outer cylindrical extent
10 45 and an inner cylindrical extent 47. The mandrel can be
11 formed of steel and the inner and outer extents 45, 47
12 together form a generally cylindrical outer working
13 surface (51 in Figure 2) between an inner end 53 and
14 outer end 55 thereof (Figure 1).

15

16 The inner and outer cylindrical extents are joined
17 at a stepped region 57 which forms a region of decreased
18 external diameter on the working surface 51 of the
19 mandrel 43. As best seen in Figure 2, the stepped region
20 57 includes a vertical shoulder 59, a cylindrical trough
21 region 61 and an outwardly sloping ramp region 63 which
22 connects to the working surface 51. A vacuum port 65 is
23 also provided on the mandrel and communicates a source of
24 vacuum pressure or positive air pressure to the stepped
25 region 57.

26

27 As shown in Figures 1 and 2, gasket 75 is installed
28 at a first circumferential position which comprises the
29 stepped region 57 of the outer working surface of the
30 mandrel. The gasket 75 comprises an elastomeric body
31 having a leading extent 77, a trailing extent 79 and an
32 interior flap portion 81. The leading extent 77 contacts

1 the vertical shoulder region 59 of the mandrel to assist
2 in retaining the gasket in position on the mandrel during
3 the subsequent manufacturing steps.

4

5 As shown schematically in Figure 1, the mandrel 43
6 is connected to a rotary drive 83 which rotates the
7 mandrel about a longitudinal axis 85 thereof.

8

9 The apparatus of the invention also includes an
10 extruder head 67 having a nozzle 69 (Figure 1). The
11 extruder head 67 is movable along the axes indicated as
12 71, 73 in Figure 1 so that the apparatus can lay down a
13 strip of thermoplastic material with the strip being
14 spirally wound about the working surface of the mandrel
15 and over the gasket 75 as the mandrel turns about the
16 axis 85 as shown in Figure 1. In other words, the mandrel
17 43 is rotated about its axis 85 while a strip of
18 thermoplastic material (87 in Figure 3) is wrapped around
19 the mandrel 43. The extruder head's axis 89 is
20 perpendicular to the rotational plane of the mandrel 43.
21 The extruder head 67 is also displaced in the direction
22 of the mandrel axis 85 in order to lay down the spiral
23 strip 87. As shown in Figure 1, the apparatus can also
24 have other conventional accessory devices such as the
25 pressure roller 91 and cutting knife 93 to facilitate
26 placement of the strip 87 and termination of the
27 extrusion.

28

29 Figures 2-6 illustrate the method steps of the
30 invention in schematic fashion. In Figure 2, the gasket
31 75 is first mounted on the forming mandrel 43 in the
32 stepped region 57 thereof. Figures 3 and 4 shown the

1 extrusion of the thermoplastic material with the strip
2 forming around the gasket and mandrel.

3

4 A number of thermoplastic materials may have the
5 desired expansion characteristics for use in the method
6 of the invention. The generally preferred materials are
7 polyolefin type materials, such as polyethylene,
8 polyvinylchloride, polyvinylchloride acetate,
9 polystyrene, and the like. The most preferred material is
10 commercially available polyethylene.

11

12 Preferably, the mandrel 43 is continuously rotated
13 and heated. The heating can be accomplished in
14 conventional fashion, as by use of a gas blower from
15 inside the mandrel or outside, or in an inductive way
16 from outside the mandrel. When the mandrel has reached
17 the desired temperature, a melt profile of the
18 thermoplastic material is extruded onto the working
19 surface of the mandrel beginning at the inner cylindrical
20 extent 47 adjacent the end 55. The extrusion is
21 preferably carried out using an extruder nozzle 69 of
22 substantially rectangular cross section, the nozzle being
23 movable in an axial direction along the mandrel, as
24 previously discussed.

25

26 Preferably, the movement of the extruder head 67 is
27 synchronized with the movement of the mandrel such that
28 the extruder nozzle, for each rotation of the mandrel 43,
29 moves in a direction toward the mandrel end 53 a distance
30 that is slightly less than the width of the melt profile
31 being extruded such that a slight overlap is obtained. In
32 this way, a spiral winding of the melt profile around the

1 mandrel and gasket is obtained with the turns of the
2 winding being located tightly above one another such that
3 a welding-together of the melt profiles is obtained. The
4 heated roll 91 can be used to improve the welding
5 together of the strips and for obtaining a more uniform
6 exterior surface of the welded body.

7

8 The extrusion continues until a desired length of
9 bell connection is obtained, after which the extruder is
10 stopped. When the extrusion is stopped, the thermoplastic
11 material is typically cooled down by spraying with
12 cooling water form the outside of the extruded bell
13 connection. The wrapping process is now complete and the
14 gasket 75 is completely encapsulated. The rotating knife
15 93 with is rotating blade may be pressed in a hydraulic
16 or mechanical way against the spiral windings to provide
17 cleanly cut ends on the connection. After the
18 thermoplastic material has cooled and set, the finished
19 "bell" can be stripped from the mandrel.

20

21 The stripping step can be accomplished in any
22 convenient manner, as by blowing pressurized air between
23 the mandrel and melt profile through port 65 at the same
24 time that a pushing force is directed against the melt
25 profile along the axis 85 of the mandrel. As shown in
26 Figure 6, the formed bell can be electrowelded or
27 otherwise joined to a straight piece of pipe so that a
28 final gasketed joint of pipe is obtained.

29

30 An invention has been provided with several
31 advantages. The improved apparatus and method provide a
32 bell connection formed from polyethylene which is not

1 subject to many of the deficiencies of the prior art due
2 to the physical properties of polyethylene and its
3 tendency to revert to its original shape after being
4 heated, formed and cooled. The bell pipe connection of
5 the invention is stable and maintains its desired shape
6 characteristics. The mechanism for forming the bell
7 connection is relatively simple in design and operation,
8 thereby providing a cost effective manufacturing process.
9 The integral gasket design of the connection provides
10 improved reliability over designs which require insertion
11 of a gasket after manufacture of the pipe joint or in the
12 field.

13

14 While the invention has been shown in only one of
15 its forms, it is not thus limited but is susceptible to
16 various changes and modifications without departing from
17 the spirit thereof.

DEPARTMENT OF DEFENSE